On the Structure and Development of the Skull in the Urodelous Amphibia. By W. K. Parker, F.R.S., F.L.S., &c.

[Abstract.]

In a paper which has recently appeared in the 'Philosophical Transactions' (1877, part ii. pls. xxi.–xxix. pp. 529–597), I have laid down the foundations of the work of which the present communication is intended to be a piece of side wall. In that initial part the development of the skull of the Axolotl is traced through *nine* stages, from the unhatched embryo to large specimens that were losing their gills.

Then this series was perfected by the addition of the skull of *Amblystoma*—one of the Salamandrians into which a *Siredon*-larva is very apt to transform itself. But as *Amblystoma* does not show the fullest type of the skull of a "Caducibranch," I have therein added an account of that of *Seironota perspicillata*, a small kind of Newt of a high type. A small larva of that species served excellently as an intercalary stage between the *third* and *fourth* of the series of Axolotls: that, also, is added to the paper.

But, as is well known, the lowest "Perennibranchs" (such as *Proteus* and *Menobranchus*) are but a sort of *ametabolous larva* as compared with the adults of the higher kinds, and have their true morphological counterparts in the early larval stage of the highest kinds. These things being so, I thought it well to add an account of the skull of an adult *Proteus* to that paper.

The present paper (the materials for which I am indebted to my kind friends, Prof. Mivart and Mr. Tegetmeir) is simply a continuation of the one just spoken of. It does not exhaust my materials, much less the subject: it may therefore be considered as Part I. I have here given an account of the skull in several kinds: some only in the adult condition, but others with one or more larval stages.

The first type treated is the common Spotted Salamander (*Salamandra maculosa*), a viviparous species. Of this kind I have worked out embryos with large branchiæ, three-fourths ripe, ripe *cryptobranch* embryos, and the adult.

Then comes another good typical Caducibranch, namely, *Notophthalmus viridesens*; of this kind I had small larvæ and the adult.

The next is only in the adult stage; this is *Cynops pyrogaster*, one of the stoutest kinds, and whose skull is like the skull of a Crocodile, both in the strength and ruggedness of its architecture.

Then I have been able to follow this with a very different adult skull, namely, that of a sharp-toed Japanese Newt (*Onychodactylus*), which is, like the gigantic *Sieboldia*, a true Cryptobranch or hemimetabolous type.

After this comes the adult skull of *Taricha torosa*, which is *almost* typically Salamandrian, but falls off a little in its *palatines*, thus leading to those that follow, in which the palatines are greatly aborted, leaving the long rows of palatal teeth to attach themselves to the parasphenoid, as the *sphenoidal teeth*. These curious forms are here represented by the genera *Spelerpes* and *Desmognathus*. Of the latter I have only the adult; but of the former the adult of *Sperlepes rubra* and a larva, the youngest of *three* larvæ; the other two being of the species *S. salmonea*.

For details I must refer the reader to the main paper; but there are a few things that may be referred to here.

In the adults of the lowest "Perennibranchs" certain bones have appeared, namely, the premaxillaries, vomers, pterygo-palatines, squamosals, frontals, parietals, and parasphenoid, besides *two* or *three* on the mandibular cartilage. These also are very early in their appearance in the larvæ of the metabolous types; afterwards, as they begin to change, other investing bones appear: the cartilaginous roof of the nose, which is absent in the lowest type, also makes its appearance, but always much later than the ear-capsule cartilage. These have a *new thing* which the Dipnoi (*Ceratodus*, *Lepidosiren*) do not possess, namely, the *stapes*. The Urodeles borrow a very primordial submucous bone from those generalized Fishes—the "pterygo-palatine," and also a cartilage from the Skates and the aberrant Sharks (*Notidanus*): this is the "antorbital," or *ethmo-palatine*.

In the Anura the "suspensorium" of the lower jaw lies so close, in infancy, to the ethmoidal region of the skull, that the ethmo-palatine cartilage and the pterygoid outgrowth of the suspensorium are not developed as distinct cartilages, but are merely conjugational *at first*.

But in the Urodeles these parts are perfectly independent; and in them the primordial "pterygo-palatine" bony plate (in the

metabolous types) is at first dentigerous, and then sends an edentulous process backwards; the bone cuts off this latter process, and then the two pieces become diversely applied to the skull proper. The tooth-bearing part, directly behind the corresponding vomer, either grows directly outwards beneath the ethmo-palatine cartilage or directly backwards beneath the *basis cranii*.

The latter condition is seen generally in Salamanders and Newts, which have a long dentigerous submesial palatine; the former modification is seen in *Amblystoma*; but in *Sperlepes* and *Desmognathus* we have these two modes combined. The edentulous bone applies itself to the pterygoid process of the suspensorium and to the inside of the body of the suspensorium (quadrate region).

In the Anura the pterygo-palatine cartilages are developed as one, and only become segmented rarely, as in *Bufo vulgaris*; but the bones are always developed independently, and not by the breaking-up of a simple primordial pterygo-palatine plate.

The transformations of the Anura are carried on in the plastic larva and *young* to a greater extent than in the Urodela.

In the Anura the opercular ray of the mandibular pier (the "spiracular cartilage" of the Shark) becomes the annulus tympanus, and a late-appearing hyomandibular becomes, by transformation, the columella auris.

In the Urodela the hyomandibular only occurs in the lower types; it is suppressed in the "Metabola" or Caducibranchs.

But some of these have a *pseudo-columella*, not lying under the facial or seventh nerve, as any part of the hyoid arch must, but *over* it, in the opercular skin. This spiraculo-stapedial bar (seen in *Menopoma*, *Spelerpes*, and *Desmognathus*) is of great interest, as showing how little *function* is to be trusted in morphology.

There have not been wanting anatomists who, failing from deficient embryological knowledge to see to the meaning of this or that part, have trusted to *teleological* explanations; but teleological science, belonging to another category of research and of thought, thus used, becomes a misleading light—an *ignis fatuus*.